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(54) **A recyclable carpet and a manufacturing process thereof**

(57) A process for the manufacture of a textile material for floor covering, in which a layer of needlepunched non-woven fabric made of synthetic fiber is formed, a layer of binder in an aqueous suspension of

a water-resistant vinyl resin having hydrolizable functionalities sufficient to be dissolved when heated in a strongly basic solvent being applied thereon. The vinyl resin can include a polymer made of polyvinyl acetate. The floor covering material thus obtained is recyclable.

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## Description

**[0001]** The present invention relates to a process for the manufacture of a textile flooring material, in particular a recyclable wall-to-wall carpeting. The invention further relates to the textile flooring material manufactured according to said process. More specifically, the invention relates to those textile flooring materials that are subject to an intensive use over a short period of time, for instance during a fair show, and are destined to be removed after use.

**[0002]** Nowadays, textile flooring materials for these types of use are manufactured using synthetic materials, essentially for their cost-effectiveness, and include a needlepunched base layer made of a synthetic fiber, mainly polyolefine fiber and in particular polypropilene fiber, held together by a layer of binding resin applied onto a face thereof. Typically, as binding resin an aqueous solution (latex) of a styrene-butadiene copolymer is used. The solution contains various additives and fillers, e.g., calcium carbonate and aluminium hydroxide, in order to increase its consistence and fire retardant properties, thickening agents for controlling its fluidity, etc.. The latex can be applied with a spreader roller drafting from a latex collection tank, or with another likewise technique, and then the latex-saturated semifinished product is heated in order to evaporate the water and dry the binder.

**[0003]** The fitting of this type of carpet is implemented by means of a two-sided tape, that also enables an easy removal of the carpet after use.

**[0004]** The most serious drawback in the use of this type of carpet lies in the fact that, once the carpet is removed after the fair, it has to be discarded as landfill waste, this resulting in a considerable cost for the user and an environmental damage. Considering the overall extension of the carpeted areas in a fair show, and the frequency of such events, the vastness of the amounts of discarded material and therefore the seriousness of this drawback become evident.

**[0005]** An object of the present invention is to provide a process for the manufacture of a textile flooring material which is able to be recycled after use by means of a treatment that entails no damage to the fiber, thus allowing the reclaiming of at least the latter and the re-introduction thereof into the manufacture cycle.

**[0006]** A particular object of the present invention is to provide an after-use recyclable carpet.

**[0007]** The above objects are attained with the process for the manufacture of a textile flooring material, the features of which are set forth in claim 1, as well as with the product yielded by such process, the features of which are set forth in claim 11.

**[0008]** The features and advantages of the process and of the product according to the invention will become clearer in the following description of one of its embodiments, given by way of example and not for limitative purposes, with reference to the annexed figure,

wherein the process according to the invention is schematically shown.

**[0009]** With reference to the aforementioned figure, the process according to the invention is conventionally based on the use of synthetic fibers received as bales that undergo a preliminary treatment indicated with 1, i. e., a processing through a machine 2 called "bale-breaker" for homogenising the batch by grading it according to the colour and to the fiber type (denier, length, crimp, composition). A first rough opening of the fiber staples, compacted by the stationing thereof inside the bales, is implemented in a carding willow 3, and then lubricating oil is added to the partly-opened fibers to let them slide into a so-called oiling cell 4.

**[0010]** The fiber compound thus obtained, or "mix", is then sent to the next manufacture step of a raw fiber panel, or felt, indicated with 5. At this stage, the fiber compound is repeatedly aired inside storage chambers 6 to which it is recirculated with a suitable device called "mill" 7. The compound thus homogenised is sent to a carding machine 8 comprising: a feeder 9 receiving the fiber from chambers 6 and laying it homogeneously, in the shape of a mat on the conveyor of the apparatus: a carding machine 10 formed by a series of toothed cylinders of various diameters providing the fiber paralleling and the laying of the same onto a conveyor belt as a light and homogeneous card web: a lap roller 11 receives the card web and lays it as a multilayer onto a conveyor belt that feeds a needlepunching apparatus 12. Needle punching is carried out in a series of knitters which, by means of the action of a plurality of needles, moving orthogonally to the fiber mat feed in a reciprocating swift motion, that seize the fibers and drag it through the fiber mass, binding and compacting therebetween. Once delivered from the needlepunching apparatus the semifinished product resembles a felt and is sent to the subsequent finishing process.

**[0011]** At this stage, a binder in a aqueous suspension contained in a collection tank 13 is applied onto the back of the felt with a spreader roller 14 drafting therefrom. The binder-saturated felt is passed through a hot air circulation drying apparatus 15 wherein layer water is removed by evaporation, yielding a flexible layer strengthened onto the back of the felt. At the outlet of the drying apparatus the finished product is delivered to a packaging unit 16.

**[0012]** According to the invention, the binder is a water-resistant vinyl resin having hydrolizable functionalities sufficient to be dissolved in a strongly basic solution when heated. A vinyl resin having such qualities comprises a vinyl acetate homopolymer or a copolymer of vinyl acetate with at least one of the following compounds:

- ethylene,
- vinyl esters of linear and/or branched C1-C20 carboxylic acids,
- acrylic, methacrylic, itaconic acid,

- acrylic or methacrylic esters of linear and/or branched C1-C20 alcohols,
- maleic and/or fumaric esters of linear and/or branched C1-C20 alcohols,
- polyvinyl alcohols with a hydrolysis coefficient from 50 to 100 and a viscosity from 4 to 50 mPa.s (4% aqueous solution). In a preferred embodiment, the resin is a copolymer of vinyl and maleic esters, as e.g. vinyl acetate and butyl maleate in a 85/15 ratio.

**[0013]** The aqueous suspension of the binder, or binding bath, contained in the collection tank 13 and applied onto the felt back, in a practical embodiment consists of an inert filler made of aluminium hydroxide or calcium carbonate, a thickening agent and water.

**[0014]** The average percent composition by weight of the binding bath is the following:

vinyl resin	20-40%
inert filler	40-70%
thickening agents	1- 5%
water	5-35%

**[0015]** Advantageously, a plastifier is further provided, preferably a molecular phthalic, isophthalic, benzoic or phosphoric plastifier, e.g. a dimethylphthalate or the like.

**[0016]** The plastifier can constitute from 0 to 40% of the binding bath, depending on the product softness required.

**[0017]** In a particularly preferred composition of the binder used in the process according to the invention the binding resin is the commercial product VINAVIL 19 WM, and the inert filler is aluminium hydroxide, 27% and 54% b/w respectively. In this case, a fire-retardant product is obtained. Alternatively, calcium carbonate can be used when fire retardant properties are not a prerequisite.

**[0018]** The binder density is regulated in order to have an applied quantity comprised from 400 to 1000 g/m<sup>2</sup> (wet basis).

**[0019]** Likewise a known carpet, the carpet manufactured with the process according to the invention is made of a layer of needlepunch non-woven fabric of a synthetic fiber, and of a layer of a resinous binder applied onto a face thereof. In addition to the same mechanical characteristics of a carpet manufactured according to the known art, the binder layer can be entirely dissolved in a strongly basic solution, e.g. a 5-30% NaOH solution, a property that is advantageously exploited in the reclaiming process of the used carpet, as is described in a corresponding patent application filed on the same date by the same applicant.

**[0020]** Once removed after use, the carpet according to the invention is first separated from possible two-sided tape and coarse dust residues, and then is scoured with a strongly basic solution, e.g., with a 15% NaOH caustic bath. Under such conditions the binder layer is

completely dissolved and the fiber can be reclaimed and recycled. The solution containing the binder and the inert filler in suspension can be reclaimed as well by acidification with a separation of the water that can be returned to the process water circuit, and of a precipitate made of the binder admixed to the filler that can be re-used to form binders for other covering materials.

**[0021]** The preferred synthetic fiber type is polypropylene, both for the cost-effectiveness and for the hydrophobic, acid- and light-resistance characteristics thereof.

**[0022]** In order to improve the fire-retardant characteristics thereof and to provide a product compliant to the regulations provided at the installation site, a certain percentage of fire-retardant modacrylic and/or polyester fiber can be advantageously added thereto, in a ratio comprised from 10 to 50%. The final unit weight of the product is comprised from about 400 to 900 g/m<sup>2</sup>.

**[0023]** Variations and/or modifications can be brought to the manufacture process of textile flooring material and to the product manufactured with said process according to the present invention, without departing from the scope of the invention, as defined by the annexed claims.

## Claims

1. A process for manufacturing a textile floor covering material starting from a baled synthetic fiber, comprising the following steps:

- homogenising and fluidizing the baled fiber;
- carding the fiber thus treated in order to obtain multilayer card webs;
- multistage needlepunching the multilayer card webs, obtaining a felt;
- applying a binder in an aqueous suspension to a face of said felt;
- heating the semifinished product thus obtained until the water is completely evaporated;

said process being characterised in that the aqueous suspension of the binder comprises a water-resistant vinyl resin having hydrolizable functionalities sufficient to be dissolved when heated in a strongly basic solvent.

2. The process according to claim 1, wherein said vinyl resin is made of polyvinyl acetate or of a copolymer of vinyl acetate with at least one of the following compounds:

- ethylene,
- vinyl esters of linear and/or branched C1-C20 carboxylic acids,
- acrylic, methacrylic, itaconic acid,
- acrylic or methacrylic esters of linear and/or

- branched C1-C20 alcohols,
- maleic and/or fumaric esters of linear and/or branched C1-C20 alcohols,
- polyvinyl alcohols with a hydrolysis coefficient from 50 to 100 and a viscosity of the 4% aqueous solution from 4 to 50 mPa.s.

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3. The process according to claim 2, wherein said vinyl resin is a copolymer of vinyl and maleic esters.

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4. The process according to claim 3, wherein said vinyl copolymer is a vinyl acetate and butyl maleate copolymer

5. The process according to anyone of the previous claims, wherein said aqueous suspension of the binder has the following percent composition by weight:

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vinyl resin	20-40%
inert filler	40-70%
water	5-35%

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6. The process according to claim 5, wherein said inert filler is aluminium hydroxide or calcium carbonate.

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7. The process according to claim 5, wherein said aqueous suspension of the binder further comprises a thickening agent in a weight percentage of from 1 to 5%.

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8. The process according to claim 5, wherein said aqueous suspension of the binder further comprises a plastifier in a weight percentage of from 0 to 40%.

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9. The process according to claim 8, wherein said plastifier is dimethylphtalate.

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10. The process according to claim 1, wherein the quantity of aqueous suspension of said binder applied to said felt is 400-1000 g/m<sup>2</sup> on a wet basis.

11. A textile floor covering material, in particular a carpeting, including a needlepunched non-woven fabric layer of synthetic fiber and a binding layer applied to a face thereof, characterised in that said binding layer is made of a water-resistant vinyl resin having hydrolizable functionalities sufficient to be dissolved in a strongly basic solvent when heated.

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12. The floor covering material according to claim 11, wherein said vinyl resin is made of a polyvinyl acetate or by a copolymer of vinyl acetate with at least one of the following compounds:

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- ethylene,

- vinyl esters of, linear and/or branched C1-C20 carboxylic acids,
- acrylic, methacrylic, itaconic acid,
- acrylic or methacrylic esters of linear and/or branched C1-C20 alcohols,
- maleic and/or fumaric esters of linear and/or branched C1-C20 alcohols,
- polyvinyl alcohols with a hydrolysis coefficient from 50 to 100 and a viscosity of the 4% aqueous solution from 4 to 50 mPa.s.

13. The floor covering material according to claims 11 or 12, wherein said vinyl resin is a copolymer of vinyl and maleic esters.

14. The floor covering material according to claim 13, wherein said vinyl resin is a copolymer vinyl acetate - butyl maleate.

15. The floor covering material according to anyone of claims 11 to 14, wherein said binding layer comprises an inert filler.

16. The floor covering material according to claim 15, wherein said inert filler is aluminium hydroxide or calcium carbonate.

17. The floor covering material according to anyone of claims 11 to 16, wherein said synthetic fiber is made of a polyolefinic fiber.

18. The floor covering material according to claim 17, wherein said polyolefinic fiber is a polypropylenic fiber.

19. The floor covering material according to claim 17, wherein said synthetic fiber includes up to 50% monoacrylic and/or polyester fiber.

